OBPR Free Flyer Draft Roadmap Overview

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Moffett Field, CA
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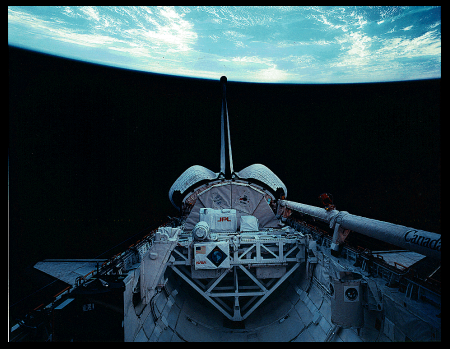
OBPR Free Flyer Roadmap Purpose

To describe OBPR research enabled by a free flying spacecraft capability

To illustrate how research performed on free flying spacecrafts complement current and planned OBPR ISS activities.

Expanding OBPR's research capabilities

Space Shuttle
1985 - 2015



Key Capabilities

- ***Short Duration micro-gravity environment***
- ***Crew tended***
- ***Circular orbit***
- ***28 – 57 degree inclination***
- ***300 km altitude***
- ***Return Capability***

Space Station
2003 - 2015

Key Capabilities

- ***Long Duration micro-gravity environment***
- ***Enhanced Crew involvement***

Free Flyer
2009 – 2025
(and beyond)

Unique Capabilities

- ***Long Duration sub-micro-gravity environment***
- ***Vastly extended orbit selection including access to radiation environments beyond the Van Allen belts***
- ***Use of hazardous species, materials, and techniques***
- ***On-demand launch and return***

1985 **2025**

NASA's Missions and Goals

OBPR is a Primary Contributor
OBPR is a Supporting Contributor

		Goals	
MISSION I	Understand and protect our home planet	1	Understand Earth's system and apply Earth system-science to improve the prediction of climate, weather, and natural hazards.
		2	Enable a safer, more secure, efficient, and environmentally friendly air transportation system.
		3	Create a more secure world and improve the quality of life by investing in technologies and collaborating with other agencies, industry, and academia.
MISSION II	Explore the universe and search for life	4	Explore the fundamental principles of physics, chemistry, and biology through research in the unique natural laboratory of space.
		5	Explore the solar system and the universe beyond, understand the origin and evolution of life, and search for evidence of life elsewhere.
MISSION III	Inspire the next generation of explorers	6	Inspire and motivate students to pursue careers in science, technology, engineering, and mathematics.
		7	Engage the public in shaping and sharing the experience of exploration and discovery.
Enabling Goals		8	Ensure the provision of space access and improve it by increasing safety, reliability, and affordability.
		9	Extend the duration and boundaries of human spaceflight to create new opportunities for exploration and discovery
		10	Enable revolutionary capabilities through new technology.

FF Goals versus OBPR and NASA Goals

NASA Goals

- Extend the duration & boundaries of human space flight to create new opportunities for exploration and discovery
- Explore fundamental principles of physics, chemistry, and biology through research in the unique natural laboratory of space.
- Create a secure world and improve the quality of life by investing in new technologies and collaborating with other agencies, industry, and academia
- Inspire and motivate students to pursue careers in science, technology, and mathematics
- Engage the public in shaping and sharing the experience of exploration and discovery.

OBPR Goals

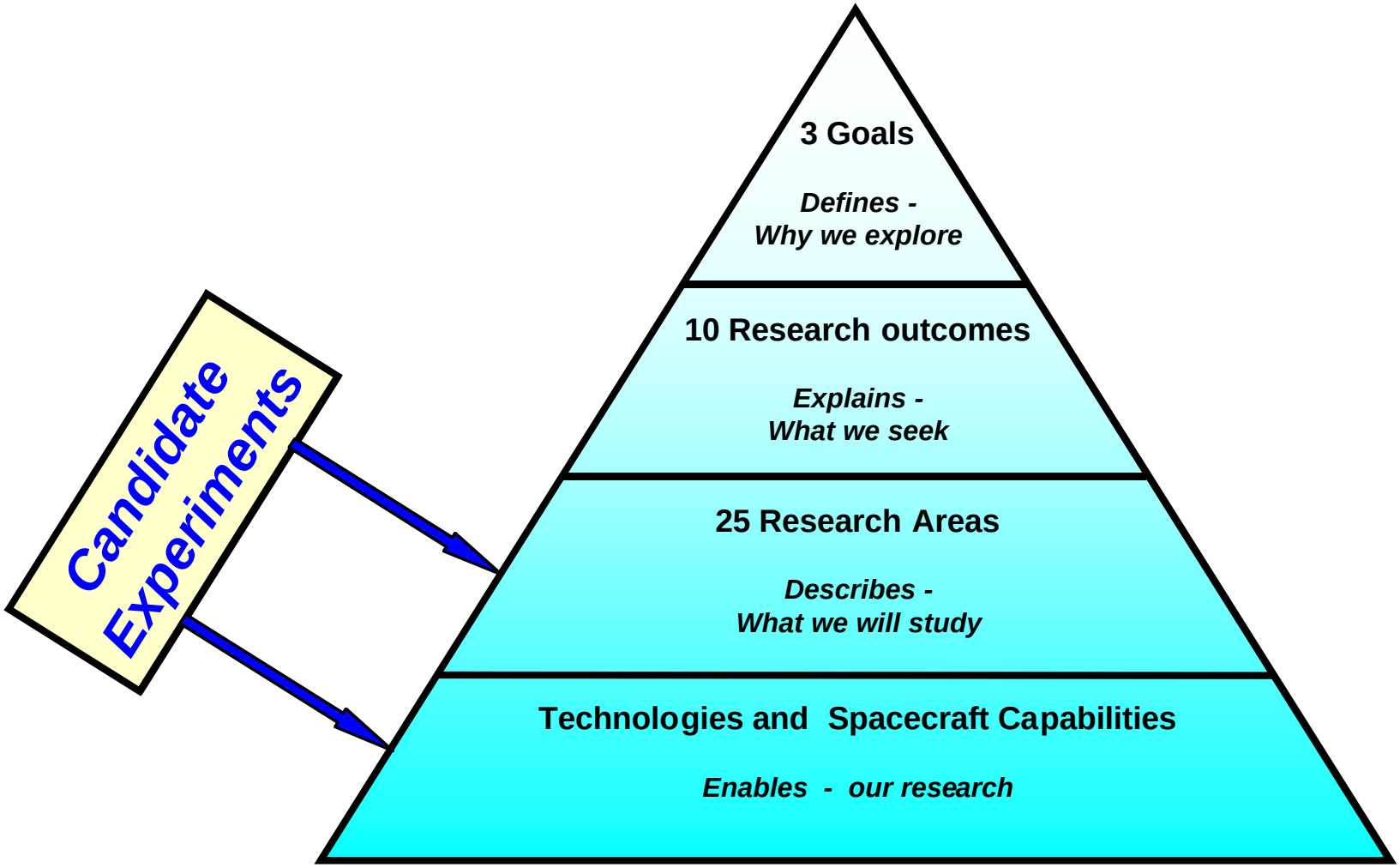
- How can we assure the survival of humans traveling far from Earth?
- What must we know about how space changes life forms, so that humankind will flourish?
- What new opportunities can our research bring to enrich lives on earth and expand understanding of the laws of nature?
- What technology must we create to enable the next explorers to go beyond where we have been?
- How can we educate and inspire the next generations to take the journey?

FF Research Goals

- Seek knowledge of how Life interacts with the Physical World using Free Flying Laboratories in Space
- Expand our knowledge of the Physical World using Free Flying Laboratories in Space
- Develop and Validate Innovative Exploration Technologies using Free Flying Laboratories in Space

E/O will be embodied in Research Goals A, B, and C

Free Flyer Draft Roadmap Overview



Goal A: ***By seeking knowledge of how life interacts with the physical world using free flyers,***

we will achieve three *Research Outcomes*:

Understand how living systems respond to continuous ultra-low gravity levels over time (OBPR 2,5)

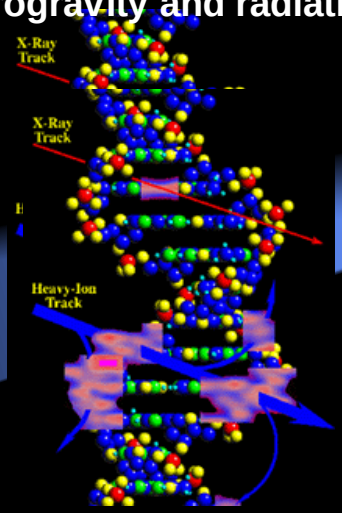
Understand the responses of pathogenic organisms and their hosts to spaceflight (OBPR 2,3,5)

Determine the molecular and cellular mechanisms underlying combined space flight effects of microgravity and radiation (OBPR 1,2,3,5)

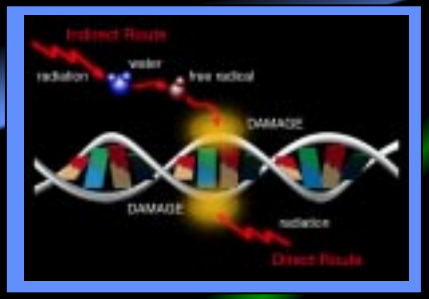
To achieve the Research Outcomes sought in Goal A,

we will pursue the following Research Areas:

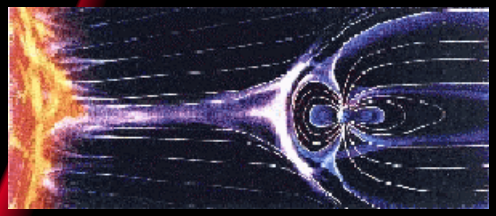
Determine the molecular and cellular mechanisms underlying microgravity and radiation



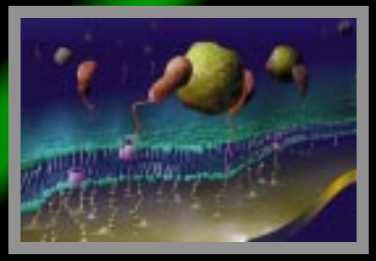
Study radiation repair mechanisms during spaceflight



Search for methods to overcome space radiation problems

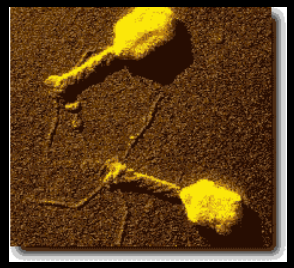


Study multiple life cycles in organisms



Develop models for cellular sensing and signaling in space

Understand course of infections in space



2010 **2025**

Goal B: *By expanding our knowledge of the physical world using free flyers,*

we will achieve three *Research Outcomes:*

Uncover new knowledge at the frontier of physics using the continuous quiescence of the sub-microgravity environment and apply results to innovative new technologies. (OBPR 3,4,5)

Develop predictive principles for technologically important physical and chemical processes that are too hazardous to study on crewed platforms. (OBPR 3,4,5)

Determine physical properties of the space environment beyond the Van Allen Belts and make knowledge available to life scientists and human exploration technologists. (OBPR 1,5)

To achieve the Research Outcomes sought in Goal B,

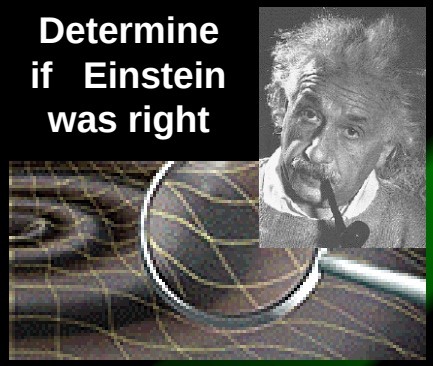
we will pursue the following Research Areas:

Map space environment properties beyond the Van Allen belts

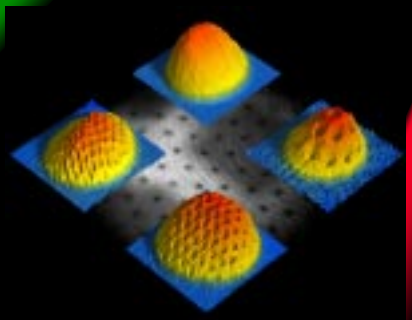
Study Violent Combustion effects Safely

Study Volatile Cryogenic systems Safely

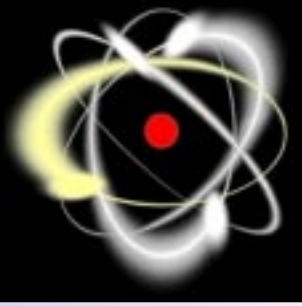
Determine if Einstein was right



Learn how complexity evolve in nature



Search for New Physics beyond the Standard Model



2010 — **2025**

Goal C: By developing and validating exploration technology using free flyers,

we will achieve four *Research Outcomes:*

Validate innovative exploration technologies for long-duration missions beyond Low Earth Orbit that cannot be validated on the ISS (OBPR 1,2,4,5)

Develop and validate countermeasures to protect life from the harmful radiation environment beyond Low Earth Orbit. (OBPR 1,3,4,5)

Verify that microgravity countermeasures proven on ISS are still effective when applied in the radiation environment beyond Low Earth Orbit (OBPR 1,3,5)

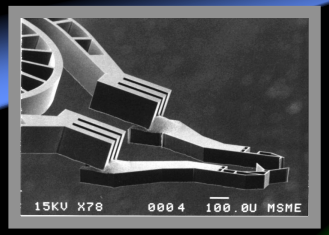
Validate hazardous and ISS-incompatible advanced spacecraft technologies (OBPR 4,5)

To achieve the Research Outcomes sought in Goal C,

we will pursue the following Research Areas:

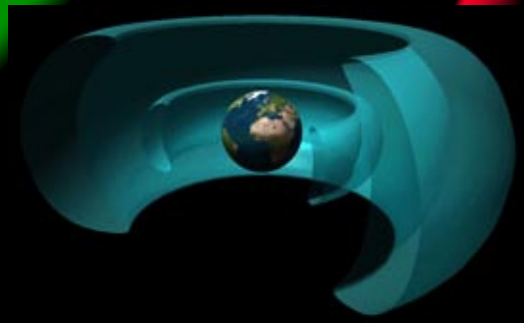
Prove that harmful µG physiological effects can be prevented

Demonstrate advanced sensors and controls



Validate critical crew life support systems

Develop new radiation shielding and countermeasure technologies



Validate advanced propulsion and power systems

Validate autonomous bio support technologies

2010 **2025**